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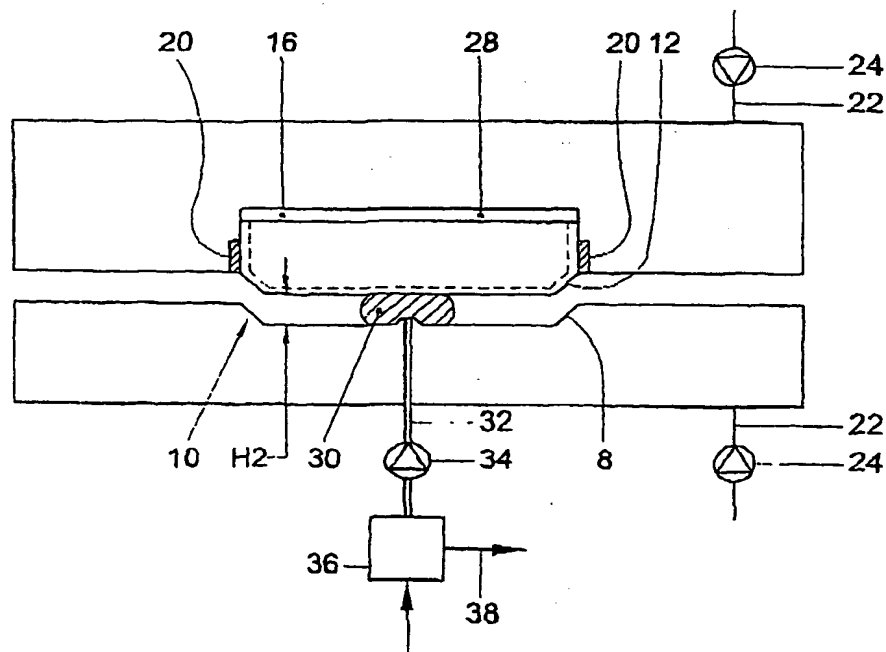
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- (54) Title: METHOD AND APPARATUS FOR FORMING THIN-WALLED PRODUCTS, AND A PRODUCT MANUFACTURED THEREWITH**



- (57) Abstract:** A method for forming thin-walled products from low-melt plastic in a mold, wherein an amount of the plastic, heated, is introduced into a mold cavity, with the mold at least partly opened, whereafter the mold is closed, such that the plastic in the mold cavity is pressed away by the wall parts of the mold cavity, whereby a complete filling of the mold cavity is obtained.



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Title: Method and apparatus for forming thin-walled products, and a product manufactured therewith.

The invention relates to a method for forming thin-walled products from plastic in a mold.

Thin-walled products are usually manufactured from plastic by injection molding in a mold. To this end, materials are used having a relatively high Melt Flow Index (MFI), at least a high melt. Such a high MFI means that the plastic in flowable form has a low viscosity and hence can traverse relatively long flow paths of small dimensions in a mold cavity. The ratio between the length of a flow path and the minimum passage height of the flow path involved is usually designated as the Melt Flow Rate (MFR). A high MFR therefore means a relatively long, narrow flow path. Injection molding is possible, in principle, with plastics having a high MFI, with a direct relation existing between the MFI and the MFR. A higher MFR requires a higher MFI. It will be clear, therefore, that plastics having a low melt, at least a low MFI, do not permit of injection molding, at least not to form thin-walled plastic products, since thin-walled plastic products have an MFR that is too high for that. This means that only products having relatively thick walls and relatively short flow paths can be injection molded from low-melt plastics. Moreover, such methods require relatively high closing forces and a relatively long cycle time, which is economically disadvantageous.

One object of the invention is to provide a new method for forming plastic products in a mold.

Another object of the invention is to provide such a method with which products can be formed in a mold from plastics having a relatively low melt.

A further object of the invention is to provide a method with which products can be manufactured in a mold, from plastic, in which a relatively

low closing force can be used and a method with which relatively short cycle times can be achieved.

These and further objects are achieved with a method according to the invention.

5 In a method according to the invention, plastic is introduced into a mold cavity whose volume differs slightly from the volume of the product to be formed therein. Only when the amount of plastic necessary for forming the product has been introduced into the mold cavity is the mold cavity brought into its final form, such that plastic is displaced and distributed  
10 throughout the mold cavity. Here, the plastic can in principle be introduced under a relatively low pressure, so that a relatively low closing force will suffice. The resistance to which the plastic is subject when being introduced will be less than when a product is injection molded from the same plastic, if this is possible at all, in the conventional manner.

15 In a method according to the present invention, plastic products can be formed relatively rapidly, that is, at low cycle times, from all kinds of plastics, and which have relatively small wall thicknesses which, moreover, if desired, may differ relatively strongly within the product.

In a further embodiment of a method according to the invention,  
20 low-melt plastic is introduced into a mold cavity in heated condition, with the mold at least partly opened. Without wishing to be bound by any theory, it seems that, as a result of this, over a first part of the filling path of the mold, flow paths are obtained having such dimensions that an MFR is obtained that matches the MFI of the plastic involved. During or after  
25 introduction of the plastic into the mold cavity such that it is partly filled with the plastic, the mold is closed, at least the mold cavity is brought into the shape corresponding to the desired final product, as a result of which the plastic is pressed further into the mold cavity. As the mold cavity initially is only partly filled, as a result of the fact that the total volume of the mold  
30 cavity with the mold open is larger than the final volume with the mold

In further elaboration, a method according to the invention is preferably characterized by the measures according to claim 5.

As a result of the thermal insulation of mold cavity forming parts from the further mold, at least from cooling means thereof, the advantage is achieved that cooling of the plastic which is introduced into the mold cavity can be delayed, in particular until the mold is partly or completely closed, at least the mold cavity is completely filled in the final form. The heat capacity of the thermally insulated forming members is preferably such that they can be heated very rapidly by the heated plastic introduced, whilst they can be cooled relatively rapidly by the cooling means of the mold. In such a method, the flow of the plastic is promoted still better, while, moreover, in the case of clear plastics, this clearness can be maintained still better.

In a further advantageous embodiment, when introducing the plastic, in any case when closing the mold, at least a part of the mold cavity forming members is retracted, so that in the substantially closed position of the mold the volume of the mold cavity is greater than the volume of the product to be eventually formed. After introduction of at least substantially all the required plastic, the retracted part is actively moved in the mold cavity so as to obtain the eventual desired shape of the product, with plastic being displaced to obtain the desired complete filling.

An additional advantage of a method according to the invention may be that after-pressing of the mold, as in conventional injection molding, can at least largely be omitted, which can simplify the required apparatuses and can lead to shorter cycle times.

It is further preferred that, in a method according to the invention, the plastic, prior to introduction into the mold cavity, is dried, at least that any moisture present is at least largely removed therefrom, so that an undesirable disturbing effect of the moisture in the mold cavity is avoided. In particular again in the case of clear plastics, this is particularly advantageous because haze formation is thereby prevented still better.

closed, a filling front is formed. Filling front should herein be understood to mean the edge of plastic in the mold cavity leading in the direction of flow. The closure of the mold can then be controlled such that directly ahead of the filling front there is always a flow path whose Melt Flow Rate  
5 approximately matches, at least is equal to or smaller than, the MFI of the plastic involved. This means that it is always ensured that plastic is displaced over the desired distance and therefore leads in a simple manner to complete filling of the mold cavity.

In a method according to the invention, preferably a mold cavity is  
10 used which, in completely closed condition, starting from the or each injection point for the plastic, has a Melt Flow Rate that is higher, in particular much higher, than the MFI of the plastic to be used, at least higher than is suitable for injection molding the plastic involved. However, when injection of plastic is commenced, the form of the mold cavity is  
15 adjusted such that an MFR is obtained that is suitable for the MFI of the plastic involved. Preferably, according as the filling degree increases, the mold cavity is brought further and further in the direction of the eventual desired form, as a result of which the plastic is continuously kept in motion and always a suitable MFR is maintained for the instant or residual part of  
20 the flow paths.

In a method according to the invention, it is preferred that during filling of the mold cavity the plastic is continuously kept in motion through movement of mold parts and/or mold cavity parts. This prevents the occurrence of undesirable solidification, so that, particularly when using  
25 transparent plastics, undesirable haze formation can be prevented. Specifically with plastics such as PET (polyethylene terephthalate) having excellent translucency and high impact strength, a method according to the invention is particularly advantageous because the clearness can thus be preserved, also in the case of molds of thin-walled products, without using  
30 conventional blow molding techniques.

Surprisingly, it has been found that with a method according to the present invention, in a simple manner, products can be manufactured that are thin-walled, while moreover hinges can be integrally formed. Such integrated hinges, usually designated as living hinges, offer the advantage that movable parts can be obtained without necessitating assembly steps. With a method according to the present invention, such hinges can even be formed in substantially completely transparent products, that is, products having a haze less than 5%, more in particular less than 3%, so that, for instance, (blister) packages, holders, and the like, with a particularly pleasant appearance can be formed.

In a further advantageous embodiment, an at least partly holder-shaped product is manufactured, with a label or like cover being provided on the inside, which screens the plastic from the contents to be received therein. This prevents contact, during use, between the contents and the plastic, which is particularly advantageous specifically if, for instance, foods, pharmaceutical products, or the like, are to be stored in the container. In such a method, also in the application mentioned, recycled plastics, such as recycled PE, PET, PS, and the like, can be used. Moreover, the advantage is thus obtained that with relatively inexpensive plastics, for instance as mentioned above, relatively thin-walled holder-shaped products can be manufactured which are light and yet sufficiently stiff.

In further elaboration, such a label can be provided on the inside of the holder-shaped part, with a printing being provided on this label, on the side facing the wall against which it is provided, or on this wall, covered by the label, the wall being manufactured from a plastic that is at least partly and preferably completely translucent, so that the printing is visible from the outside of the product. The printing is thus protected from influences from outside, while, as indicated, contact between the plastic and the contents during use is avoided. To apply a label, for instance in-mold labeling technique can be used, or the label can be inserted later. Of course,

the printing can also be provided on the inside of the holder, after which it can be covered, for instance by a protective layer of lacquer or the like. In an alternative embodiment, at least the holder-shaped part of the product can also be labeled and/or printed on both sides, that is, the inner side and outer side.

The invention further relates to a mold-formed, substantially thin-walled plastic product, characterized by the features according to claim 18.

Such a product offers the advantage that all kinds of particular product characteristics can be obtained that could not be obtained in products according to the state of the art. Thus, for instance, products can be formed from plastic having a melt that is particularly low, for instance an MFI less than 18, with wall thicknesses that are particularly small in proportion to the other dimensions of the wall parts involved. Thus, for instance, bent or flat wall parts can be obtained that have a thickness of a few tenths of millimeters, with outer dimensions of the respective wall part of a few centimeters or more; products that could hitherto be manufactured only from plastics having a high MFI, for instance polyethylene or polystyrene.

A product according to the invention can be manufactured in a relatively inexpensive and simple manner from relatively inexpensive plastic, having, for instance, impact strength, flexibility, with integrated hinges, being crystal-clear or opaque, while moreover materials can be used that have less environmental impact than, for instance, PVC.

A product according to the invention may be manufactured, for instance, from PET (polyethylene terephthalate), with, for instance, at least one living hinge, and is particularly suitable as storage device for, for instance, disk-shaped data carriers such as CDs, CDi, CDRom, Chipcard, Simcard, or the like, but also for other products, for instance papers, foods, and the like, also as a blister package.



The invention further relates to an apparatus for forming products according to the invention or the use of a method according to the invention, characterized by the features according to claim 27.

Such an apparatus enables particularly simple manufacture of  
5 products that are relatively thin-walled, with relatively long flow paths, that is, having a high MFR, from plastic having a low melt, at least low MFI. Thus, products can be manufactured that have particularly advantageous product characteristics, such as, for instance, high clearness, high impact strength, high flexibility, low cost, FDA approval, recyclability,  
10 monopackages, suitability for low and/or high temperatures, and the like, depending on the selected plastic.

In a method and apparatus according to the invention, furthermore, the advantage is achieved that the closing force for closing the mold and keeping it closed is relatively low with respect to that required in the  
15 manufacture of comparable products in a conventional manner, that is, by injection molding. This means that relatively small, light machines can be used.

In the further subclaims, further advantageous embodiments of a method, product and apparatus according to the invention are described. To  
20 clarify the invention, exemplary embodiments of a method, product and apparatus according to the invention will be elucidated in more detail with reference to the drawing. In the drawing:

Figure 1 diagrammatically shows, in sectional side view, an apparatus according to the invention;

25 Figures 2 and 3 show, in two steps, the use of an apparatus according to Figure 1;

Figures 4A-C show, in three steps, the filling of a mold cavity in a method and apparatus according to the invention;

Figure 5 diagrammatically shows, in sectional side elevation, an  
30 alternative embodiment of an apparatus according to the invention;

Figures 6-8 show, in side view, top view, and partly sectional front view, a storage device according to the invention;

Figure 9 diagrammatically shows, in side view, a holder manufactured with a method and apparatus according to the invention;

5        Figures 10A-C show, in three steps, the use of an apparatus according to the invention, in an alternative embodiment;

Figure 11 diagrammatically shows, in perspective view, a product formed with an apparatus according to Figure 10;

10        Figure 12 shows a further alternative embodiment of a container according to the invention;

Figures 13A-B show, in sectional view, a portion of a wall of a product according to Figure 12; and

Figure 14 diagrammatically shows, in sectional side view, an apparatus according to the invention in a further alternative embodiment.

15        In this description, the same or corresponding parts have the same or corresponding reference numerals. In this description, the designation Melt Flow Rate (MFR) is used, which is a conventional designation for the ratio between the minimum passage height in a flow path, at least the minimum passage, and the length of the flow path. In addition, the term Melt Flow  
20        Index (MFI) is used, which is a material-related index for the viscosity in "flowable" form, that is, at a temperature at which the plastic can flow at least to some extent. The MFR and MFI are standardized *inter alia* in ISO standard 1133. It will be clear, however, that the present application is not limited thereto.

25        Figure 1 diagrammatically shows, in sectional side view, a portion of an apparatus 1 according to the invention, which comprises a mold 2 provided with a first mold part 4 and a second mold part 6. The second mold part 6 includes a female part 8 of a mold cavity 10; the first mold part 4 includes a male mold part 12 of the mold cavity 10. The male mold part 12  
30        is defined by a forming member 14, which is movably included in a cavity 16

in the first mold part 4. The forming member 14 is of hollow design with relatively thin walls 18, shown by the broken line, so that the heat capacity of this forming member 14 is relatively low. Provided around the forming member 14 is a thermally insulating seal 20 over a part of the height of the chamber 16, while the first and second mold parts 4, 6 are provided with cooling means 22, diagrammatically indicated by a line with a pump 24. These cooling means 22 are designed, for instance, in a conventional manner as cooling channels (not shown) extending around the mold cavity 10, through which channels cooling liquid can be pumped at a relatively low temperature, for instance a few degrees Celsius.

In Figure 1, the mold 2 is shown in the opened position, such that there is a distance X between the land areas 26. Included in the chamber 16 are pressure means for biasing the forming member 14 into an extended position, shown in Figure 1, such that the male part 12 is located at a relatively small distance  $H_1$  from the female part 8, at least the bottom thereof. The pressure means in the chamber 16 may be formed, for instance, by a slightly compressible liquid, elastic material, or the like, or, as will be described in more detail with reference to Figure 5, comprise controllable pressure means. The pressure means 28 in the chamber 16 are of such design that upon introduction of plastic 30 into the mold cavity 10 the male mold part 12 can be pressed away into the chamber 16, so that the distance between the male part 12 and the female part 8 increases, for instance to a distance  $H_2$ . Plastic 30, for instance polyethylene terephthalate (PET) or another plastic having a low Melt Flow Index, for instance less than 18, more particularly less than 12, and preferably for instance about 6 or less, is introduced into a mold cavity 10 via an injection channel 32 with the aid of a pump 34 or another injector known from the injection molding technique, while displacing the forming member 14, which forming member, as a result of the temperature of the plastic, for instance about 270°C for PET, is rapidly heated to a comparable temperature, thermally insulated by the

seal 20. This prevents a premature change of the material characteristics, in particular solidification and hazing of the plastic 30, in particular the PET mentioned. Prior to introduction of the plastic 30 into the cavity 10, the plastic 30 is dried in a device 36, for instance by suitable preheating, with  
5 moisture 38 being discharged.

After the plastic 30 has been introduced into the mold cavity 10 as a relatively thick, highly viscous liquid, while the space in the mold cavity 10 is relatively large due to the distance  $H_2$ , the mold is closed, as shown in Figure 3. In this condition, the forming member 14 is virtually completely  
10 received within the chamber 16, and the land areas 26 are in mutual abutment. The mold cavity 10 is completely filled with plastic 30, whilst the desired shape of the product 40 has been obtained. In this situation, there is relatively much contact between the mold part 4 and hence the cooling means 22 and the forming member 14, as a result of which the desired  
15 cooling of the product 40 is obtained, such that upon complete opening, that is, further than the distance X in Figure 1, the product 40 can be taken out, and the mold can be made suitable for a new production cycle. During the filling of the mold cavity and closing of the mold, it is ensured that the plastic 30 keeps flowing continuously, in the direction of the ends of the  
20 mold cavity 10, thereby preventing the occurrence of premature undesired changes in the material characteristics.

It has been found that in particular when using, for instance, PET, it is particularly advantageous if the plastic keeps flowing continuously during introduction into and filling of the mold, while prior to introduction  
25 this plastic has been dried nearly completely and the walls of the mold cavity 10 are relatively warm during filling of the mold, because in this way the clearness of the plastic is maximally preserved. This affords the possibility of manufacturing thin-walled products as shown in, for instance, Figures 6-9 as a replacement of, for instance, polystyrene, polycarbonate,  
30 polypropylene, and the like.

It has been found that a method according to the invention is particularly suitable for use with crystalline plastics such as PET, polycarbonate and the like. Without wishing to be bound by any theory, this seems to be the result of the orientation direction of the monomer and/or polymer chains and the fact that such plastics in principle have a relatively small transition range between fluid and solid form. Such plastics seem to have a glass transition point rather than a glass transition range, as a result of which the temperature control in the mold is particularly critical. A method according to the invention enables controlling the temperature in the plastic such that it always remains fluid until the mold cavity has been filled. Thus, where relevant, the transparency is maintained. A further advantage of the relatively low pressure at which the plastic is introduced into the mold cavity seems to reside in the fact that the polymer chains are subject to less strong loading during the introduction of the plastic, so that stresses in the plastic and in the final product are reduced notably. Thus, a product is obtained which is more form stable, while, moreover, so-called oil stain effect on the surface of such plastic products, causing discoloration on the surface, is prevented. Stresses in plastic products can generally be demonstrated by ultraviolet light.

Figure 5 diagrammatically shows, in sectional side view, an alternative embodiment of an apparatus according to the invention. In this embodiment, not only the male part 12 is movably received in a chamber 16 as part of a forming member 14, but also the female part 8 on a second forming member 14A in a second chamber 18A in the second mold part 6. In this embodiment, the means 28 for biasing the forming members 14, 14A are designed as at least one supply line 42 with a pump 44 for introducing into the chamber 16, 16A, or discharging therefrom, a pressure liquid such as hydraulic oil, with which in each case the counterpressure of the two forming members 14, 14A and hence the distance H can be accurately controlled. Again, the forming members 14, 14A of the mold parts 4, 6 are

thermally separated by the sealing means 20, 20A, at least in the position shown in Figure 5. Only when closing the mold 2 does thermal contact arise between the mold parts 4, 6 and the forming members 14, 14A for cooling them and hence the product. It will be clear that combinations of the  
5 different parts as shown in Figures 1-3 and 5 are possible.

Figures 4A-C diagrammatically show the flow of the plastic 30 in the mold cavity 10. In these Figures, the plastic 30 is represented by hatching, the mold cavity is represented diagrammatically as a rectangle.

In Figure 4A, the distance  $H_2$  between the mold parts is relatively  
10 great, as a result of which the plastic 30 has moved from the inflow line 32 over a relatively short distance  $D_1$  into the mold cavity 10, to either side, at least, to all sides. The flow front 50 is therefore located close to the inlet opening 32.

After the desired amount of plastic 30 has been introduced into the  
15 mold cavity 10, the supply line 32 is closed, diagrammatically represented by a cross 52, and the distance between the mold parts is reduced to  $H_x$ , as a result of which the flow front 50 is displaced in the direction away from the supply line 32, so that the total flow path of the plastic 30 increases to  $D_2$ . This means that between Figures 4A and 4B the plastic has been moved  
20 over a distance  $D_2 - D_1$ , with decreasing passage height  $H$ .

When the mold parts, at least the parts forming the mold cavity 10, are moved further towards each other, the flow front 50 is pushed away still further, until, as shown in Figure 4C, the mold cavity 10 is completely filled and the desired product thickness  $H_1$  has been reached. It will be clear that  
25 just before the condition as shown in Figure 4C has been reached, the plastic must be pressed through a minimal passage height  $H_1$ . Since this needs to be done only over a very short distance, in each case a suitable Melt Flow Rate matching the plastic has been obtained.

In Figures 6-8, a storage device 70 is shown, known per se from the  
30 international patent application PCT/NL/96/00459, which, as an example, is

understood to be incorporated herein by reference. It is expressly observed that this example should in no way be interpreted in a limitative sense.

5 A device 70 according to the invention is particularly suitable for storage and transmission of data carriers such as CDs 72. Data carriers should herein be taken in the broadest sense of the word and may also comprise other data carrying products, such as paper, cardboard, plastic, provided with printing, figures, text, or the like.

10 A storage device 70 according to the invention comprises a first cover part 47, a second cover part 76, and an intermediate part 78 connecting the two cover parts 74, 76. The cover parts 74, 76 are provided with edges 80, 82 such that in closed position a closed package is obtained, as diagrammatically represented by the broken line 84. Diagrammatically shown are closing means 81, 83 which can keep the storage device 70 in closed position. The intermediate part 78 is connected on opposite sides via  
15 an integrated hinge (living hinge) to an adjacent cover part 74, 76. Provided on the intermediate part 78 are fixing means 86, for instance in the form of pairs of clamping fingers 88, between which an edge of the data carrier 72 can be clamped, as represented in Figure 8. Optionally, the fingers 88 may be interconnected by ridges 90 for increasing the clamping force. It will be  
20 clear that the data carrier can be fixed, at least enclosed, in the storage device 70 in many different ways, for instance also in a manner as known from the jewel box, on one or both cover parts 74, 76. These and other fastening means are sufficiently known from practice.

25 In a particularly advantageous embodiment, a storage device 70 according to the invention, for instance as shown in the drawing, is manufactured from a clear translucent plastic such as PET and manufactured in the manner described earlier, so that translucency is fully preserved. Here, the haze can be, for instance, less than 5%, even less than 3%. Given suitable process parameters, which can be easily determined

within the outlined limits by those skilled in the art, even a substantially completely haze-free plastic can be obtained.

In Figure 9, an alternative holder 92 is shown, in the form of a cup-shaped container 94 with a cover 98 connected thereto via a hinge 96. The hinge 96 is integrally formed, that is, integrated with the container 94 and the cover 98. In the same manner, a blister package can be manufactured, for instance by making the container 94 of slightly less high design, while closing means may be provided in a conventional manner, which can be integrally formed, for locking a product or products to be packaged in the blister.

In a method according to the invention, for instance used with a holder 92 according to Figure 9, different parts can acquire different degrees of translucency, for instance by cooling the cover part 98 of the mold sooner, making this part slightly milk white and less translucent, opaque. It is even possible to give different cooling rates to different surface portions of mold forming members, so that, for instance, on a relatively clear cover part an opaque logo can be formed as an integral part, without, for instance, other roughnesses being necessary, although such is possible.

Figures 10A-C schematically show in sectional side elevation an apparatus 1 according to the invention, in a further alternative embodiment, in three successive steps when using a method according to the invention. The same parts again have the same reference numerals.

In Figure 10A, the mold 1 is shown in opened position. The lower mold half 6 comprises a female part 8 of the mold cavity 10; the upper mold half 4 comprises a male part 12, partly defined by a slide 13, which can slide along a fixed part 12A. In the embodiment shown, the slide is connected to a connecting rod 28A and a schematically represented piston-cylinder assembly 28B. However, any other suitable manner may naturally be used for moving the slide 13, for instance as described earlier. When the mold 1 is



open, as represented in Fig. 10A, the slide 13 is retracted, that is, moved in the direction of the upper mold part 4, away from the female part 8.

In Fig. 10B, the mold halves 4, 6 have been moved onto each other, so that the mold cavity 10 is closed, with the slide 13 held in the retracted position and the volume of the mold cavity 10 being greater than the volume of the product to be formed. The distance  $H_2$  between the free end of the slide 13 and the opposite bottom surface of the female part 8 is then relatively great. In this condition, plastic is introduced into the mold cavity 10 via the supply line 32. The amount of plastic is adjusted to the volume of the eventual product to be formed, for instance a holder 92 as shown in Fig. 11.

After the plastic has been introduced into the mold cavity 10, then, as represented in Fig. 10C, the slide 13 is moved further into the female part 8 of the mold cavity 10, such that the distance  $H_1$  between the free end of slide 13 and the bottom surface of the female part 8 corresponds to the desired wall thickness. As a result, in the manner described earlier, plastic is displaced, so that a complete, at least desired, filling of the mold cavity 10 is obtained.

Fig. 11 schematically shows in perspective view a product 92 with a holder-shaped part 93 and a back wall 94, for instance formed with an apparatus according to Fig. 10 or 14.

Fig. 12 shows an alternative embodiment of a holder-shaped product 92 according to the invention, for instance in the form of a butter tub which comprises a longitudinal wall 94 with a flanged upper edge 95 and in whose interior 99 contents can be stored, for instance foods such as butter or margarine, other spreads, pharmaceutical or body care products or the like, or products of a different nature. On the inner side 99 of the wall 94, as shown in Fig. 13A, a lining 97 has been provided, in particular a plastic label which may be provided, for instance, by in-mold labeling. The label 97 preferably covers the complete inside of the wall 94, extending as far as or

over the longitudinal edge 95, so that direct contact between the wall 94 and the contents on the inside 99 is avoided. The wall 94 can be manufactured, for instance, from recycled plastic without FDA approval, while the label 97 preferably is suitable for contact with foods, pharmaceuticals and the like. It is preferred here that the wall 94 is manufactured from translucent plastic such as PET, while on the side of the label 97 proximal to the wall 94, a printing 91 is provided, which is visible from the outside of the container 92, through the wall 94. Incidentally, the printing 91 can also be provided against the wall 94 and subsequently be covered by a covering, for instance the label 97.

Fig. 13B shows a sectional view of a wall part of the container 92, with a first label 97 provided on the inside and a second label 97A on the outside. Thus, the wall 94 is protected on both sides, while moreover an attractive appearance is obtained.

In Fig. 14, a further alternative embodiment of an apparatus 1 according to the invention is shown, somewhat similar to that shown in Fig. 10. In this embodiment, however, a slide 13 is movable in a direction  $P_1$ , at right angles to the direction  $P_2$  in which the mold parts 4, 6 can be moved relative to each other. An activation slide 28 as an operating means for the slide 13 is provided in the upper mold part 4, which is movable in a direction  $P_3$ . In the embodiment shown in Fig. 14, in this apparatus 1 a product 92 can be formed, having a holder-like part 98 and a cover 98 connected thereto via a hinge 96. With the mold open (not shown), the slide 13 is moved away to a maximum extent, to the left in Fig. 14, so that a product 92 comes off it and can be removed. Thereupon, the slide 13 is moved back to the position shown in Fig. 14 and the mold parts 4, 6 are pressed onto each other, so that a mold cavity 10 is obtained having a volume slightly greater than the volume of the product to be formed. Specifically, for the free end 13E of the slide 13, shown on the right-hand side in Fig. 14, a cavity 10A is provided. The distance  $H_2$  between the free

end 13E and the opposite surface of the mold cavity is greater than the wall thickness to be formed there. After the mold has been closed and plastic 30 has been introduced into it, the slide 28 is moved, in downward direction in Fig. 14, so that, due to the cooperating inclined surfaces 28C, 28D, the slide 5 13 is moved to the right over a distance such that plastic is pressed away into the cavity 10A and the distance between the free end 13E and the opposite surface is reduced to a distance H in accordance with the desired bottom thickness.

Movement of the slide 28 can be obtained, for instance, with the aid of 10 the mechanism with which the mold halves 4, 6 are pressed onto each other, but can also be effected in a different way, for instance by external means, hydraulically, pneumatically or otherwise.

The holder 92 as shown in Fig. 14 can be, for instance, a multimedia storage device, as described earlier, but may also be a different kind of 15 device provided with parts that can be formed with moving mold parts. It will be clear that any combination of methods, apparatuses and products, as well as parts thereof and plastics which have only been mentioned by way of example is possible within the scope of the invention outlined by the claims.

In a method and apparatus according to the invention, the additional 20 advantage is achieved that relatively low injection pressures can be used.

The invention is not limited in any way to the exemplary embodiments shown in the description and the drawing. Many variations thereon are possible within the scope of the invention outlined by the claims.

25 Thus, different parts of different exemplary embodiments described can be combined and varied, for instance different mold shapes and different means for creating counterpressure for the movable mold parts. Also, a single mold may include several mold cavities and also products may be formed without a hinge or with several hinges. Other plastics can be used, 30 having a relatively low Melt Flow Index, such as, for instance, PC, PON,

PEN and the like. Plastics having a higher MFI, such as PP, PE and the like can also be processed using a method according to the invention, whereby at least a part of the advantages are achieved. Also products of a different kind can be manufactured with a method and apparatus according to the invention, for instance trays, household products, cladding elements, while moreover other means can be employed for closing holders, such as screw thread, bayonet means and the like, which can be integrally formed. Also, all kinds of other means can be used for biasing the movable forming members. Also, these movable forming members can be designed such that the mold parts are first moved against each other and thereupon the or each forming member is moved in such a manner, for instance with means as shown in Fig. 5, that the mold cavity is brought into the desired shape. It is incidentally noted that an advantage of the method described earlier is that deaeration of the mold cavity is possible in a particularly simple manner. If desired, or necessary, the or each movable mold part can be preheated. Also, in a mold according to the invention, two-component technique can be employed and several injection points can be used.

These and many comparable variations are understood to fall within the scope of the invention outlined by the claims.

## CLAIMS

1. A method for forming thin-walled products from plastic in a mold, wherein an amount of said plastic, heated, is introduced into a mold cavity while the mold is at least partly open, whereafter the mold is closed, such that the plastic in the mold cavity is pressed away by the wall parts of the mold cavity, whereby a complete filling of the mold cavity is obtained.
2. A method according to claim 1, wherein a plastic is used having a relatively low melt, in particular a melt which is so low that the product to be formed therefrom is not moldable in a mold by conventional injection molding.
3. A method according to claim 1 or 2, wherein a mold is used of which at least one wall part is movably arranged, wherein during introduction of the plastic, said at least one wall part is pressed away by the plastic, such that between said at least one wall part and an opposite wall part a flow passage for the plastic is formed having a thickness, measured between said wall parts, that is greater than the thickness of the product part to be formed therefrom, and wherein during closure of the mold said flow passage is closed to some extent to the desired thickness for the product part to be formed at that point.
4. A method according to any one of claims 1-3, wherein during the introduction of the plastic and the closure of the mold the plastic is continuously kept in motion, until the whole mold cavity is closed.
5. A method according to any one of the preceding claims, wherein a mold is used of which at least movable mold cavity-defining wall parts, and preferably all mold-forming wall parts, when the mold is open, are thermally insulated from the further mold, wherein said thermally insulated wall parts of the mold are designed such that they have such a low heat capacity that the temperature of these wall parts, when the plastic

is introduced, is raised to a temperature close to the temperature of the plastic, while the other mold parts are kept relatively cool, and wherein during closure of the mold said wall parts of the mold cavity are cooled by thermal conduction between said wall parts and the further relatively cold mold parts.

5 6. A method according to any one of the preceding claims, wherein a mold is used in which the or each mold cavity comprises a male and a female part, at least the male part being movably confined in a mold part, the confinement being so designed that an outwardly facing surface of the male part, when the mold is open, is held relatively close to an opposite surface of the female part, wherein the plastic is introduced between said surfaces under a pressure such that the male part is to some extent pushed away for providing a desired flow passage, while the pressure with which the male part is forced outwards is smaller than the pressure of the plastic when being introduced.

15 7. A method according to any one of claims 1-5, wherein a mold is used in which the or each mold cavity comprises a male and a female part, at least the male part being movably confined in a mold part, the confinement being so designed that an outwardly facing surface of the male part, when the mold is open, is held relatively far from an opposite surface of the female part, wherein the plastic is introduced, wherein the male part, at least after the plastic has been introduced, is forced in the direction of the female part for obtaining the desired product, wherein the plastic is partly pressed upon in the mold cavity by the male part.

25 8. A method according to any one of the preceding claims, wherein the plastic, prior to being introduced into the mold cavity, is dried, such that at least largely the moisture is removed therefrom.

9. A method according to claim 8, wherein drying of the plastic is obtained by preheating.

10. A method according to any one of the preceding claims, wherein a mold cavity is used with a Melt Flow Rate (MFR) which in closed condition is too high for the Melt Flow Index (MFI) of the plastic to be used, wherein the mold, when the plastic is introduced, is set such that at least a first part  
5 of the flow path has such dimensions as to meet the minimum Melt Flow Index (MFI) and Melt Flow Rate (MFR) for the respective plastic and product dimensions, while during and/or after introduction of the desired amount of plastic into the mold cavity, the mold is closed, such that in each case a flow front of the plastic arises which is chosen such that the residual  
10 part of the mold cavity yet to be filled has a Melt Flow Rate (MFR) that matches the Melt Flow Index (MFI) of the plastic.
11. A method according to any one of the preceding claims, wherein in the product at least one hinge is integrally formed in the mold cavity.
12. A method according to any one of the preceding claims, wherein a  
15 clear, translucent plastic is used.
13. A method according to any one of the preceding claims, wherein a plastic is used having an MFI of less than 18, in particular less than 15, more particularly less than 10 and preferably at most 6.
14. A method according to any one of the preceding claims, wherein PET  
20 is used, at least a plastic having a comparable MFI.
15. A method according to any one of the preceding claims, wherein at least on the inside of a holder-shaped part of the product a label or like covering is provided, which screens the plastic from contents to be received therein.
- 25 16. A method according to claim 15, wherein the plastic used is at least partly recycled plastic.
17. A method according to claim 15 or 16, wherein the plastic used is at least largely translucent, wherein said label is provided on the inside of the product, preferably by in-mold labeling, wherein on said label a printing is  
30 provided which is visible through the wall of the product.

18. A mold-formed, substantially thin-walled plastic product, manufactured from a plastic having a relatively low MFI, for instance less than 18, wherein it holds for parts of the product that the MFR calculated from a position of introduction of the plastic into the mold cavity in which the product has been formed is greater than matching the MFI of the plastic.
19. A product according to claim 18, wherein the product has been formed from a plastic having an MFI less than 15, in particular less than 10 and preferably at most 6.
20. A product, preferably according to claim 18 or 19, which product is at least partly somewhat holder-shaped, while on the inside of said holder-shaped part a label has been provided, such that the wall of said holder-shaped part facing the inside is covered thereby.
21. A product according to claim 20, wherein said plastic has no food approval, while the label does have food approval.
22. A product according to claims 18-21, wherein the plastic is translucent, in particular clearly translucent with a haze less than 5%, more particularly less than 3%.
23. A product according to any one of claims 18-22, wherein the product is manufactured from PET.
24. A product according to any one of claims 18-23, wherein the product is provided with at least one integrated hinge.
25. A product according to any one of claims 18-24, wherein the product is a storage device for a multimedia carrier, in particular a storage device for a disk-shaped information carrier.
26. A product according to claim 25, wherein clamping means for the information carrier and closing means for the storage device have been integrally formed.
27. An apparatus for forming products according to any one of claims 18-26 or for use of a method according to any one of claims 1-17, comprising



a mold having at least one mold cavity, wherein at least a part of the mold cavity wall is movably arranged and is biased into an extended position, wherein means are provided for introducing plastic into the mold cavity, at least against said movable mold cavity wall part, under such pressure that this mold cavity wall part can thereby be pressed away, wherein means are provided for closing the mold after plastic has been introduced into the mold cavity, which means are so arranged that, with the mold closed and the mold cavity filled with plastic, the or each said movable mold cavity wall part has been moved from the extended position to a retracted position for defining the outer shape of the product to be formed.

28. An apparatus for forming products according to any one of claims 18-26, or for use of a method according to any one of claims 1-17, comprising a mold having at least one mold cavity, wherein at least a part of the mold cavity wall is movably arranged and can be brought into a retracted position, while means are provided for introducing plastic into the mold cavity, at least against said movable mold cavity wall part, and means are provided for closing the mold after plastic has been introduced into the mold cavity, which means are so arranged that with the mold closed and the mold cavity filled with plastic, the or each said movable mold cavity wall part can be moved from the retracted position to an extended position for defining the outer shape of the product to be formed.

29. An apparatus according to claim 27 or 28, wherein the mold cavity is at least partly and preferably wholly defined by one or more forming members which, with the mold open, are thermally insulated from cooling means of the further mold, and when the mold is being closed a thermal coupling is obtained between the or each forming member and the said cooling means, the heat capacity of the or each forming member being relatively low with respect to the heat capacity of the further mold, at least of the cooling means, such that the or each forming member can be heated

up relatively fast by the heat of the plastic to be introduced into the mold cavity, and can be cooled relatively fast by the cooling means.

30. An apparatus according to any one of claims 27-29, wherein furthermore means are provided for drying the plastic prior to introduction thereof into the mold cavity.
- 5

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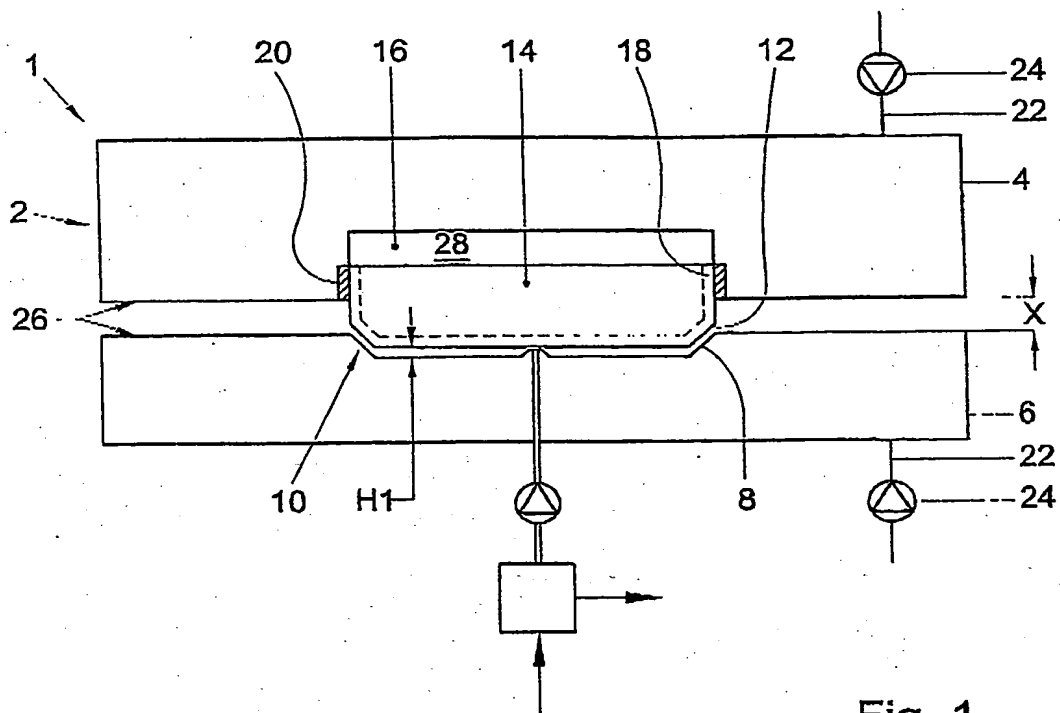


Fig. 1

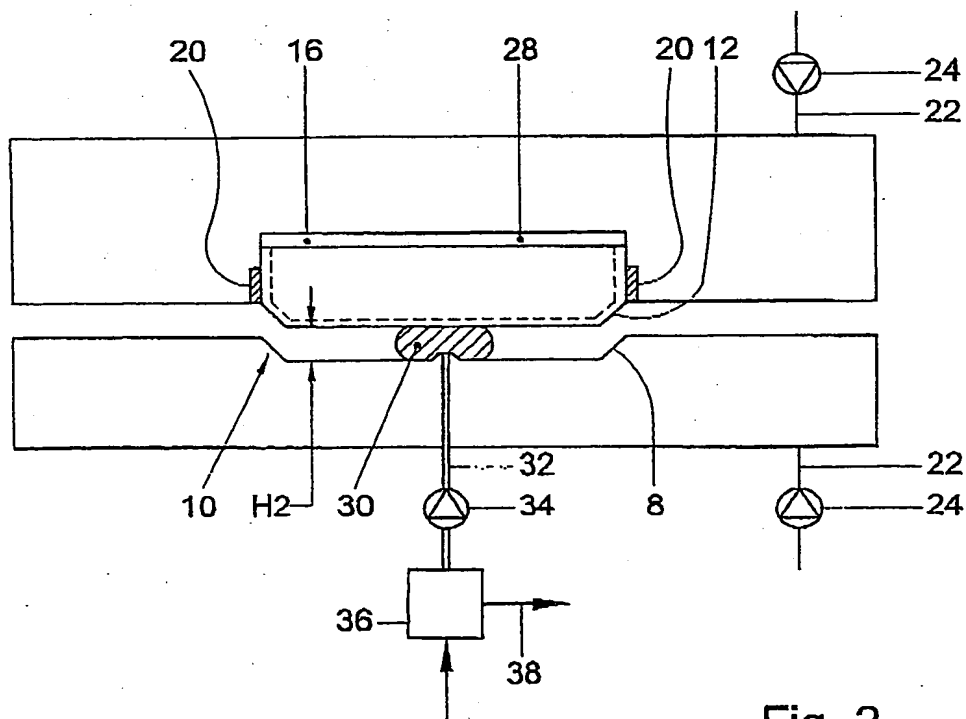


Fig. 2



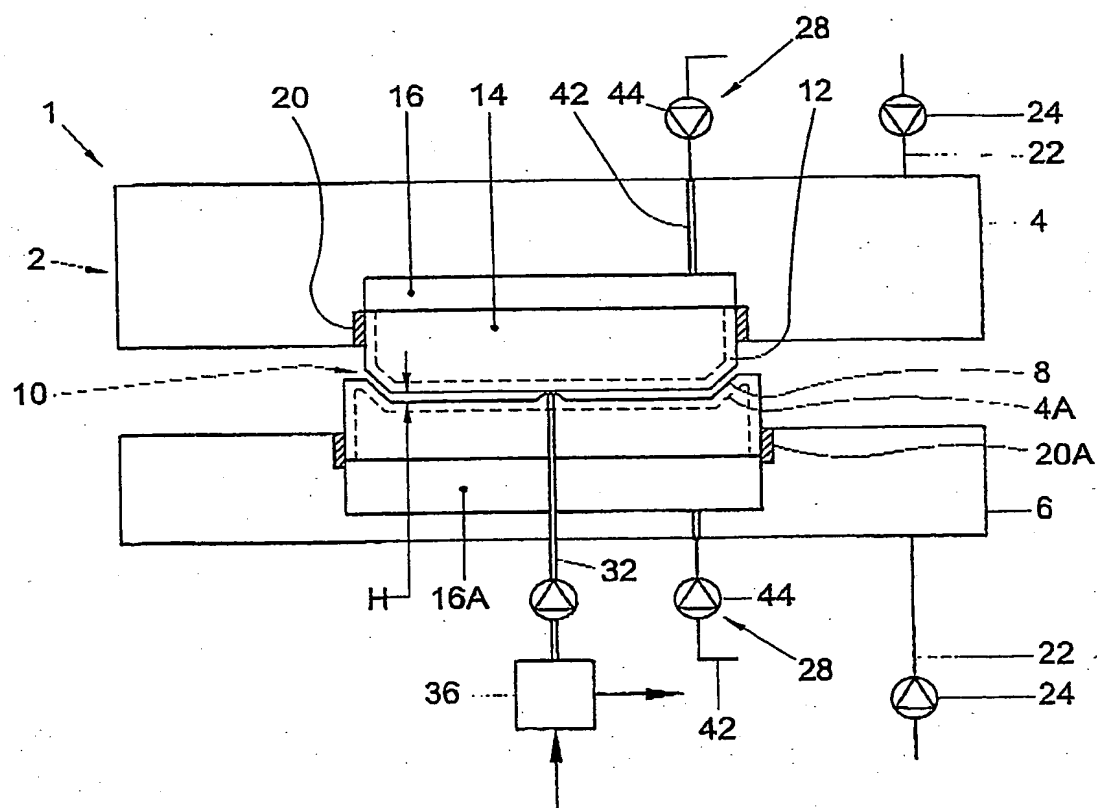
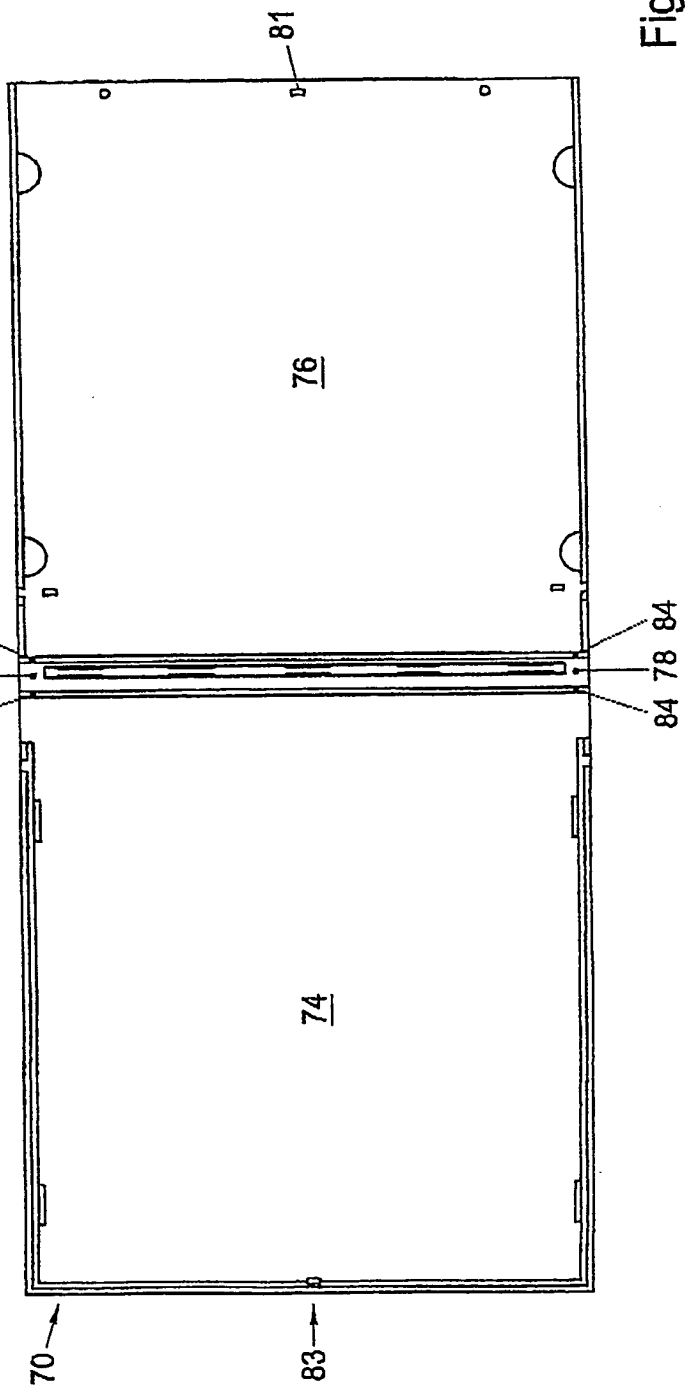
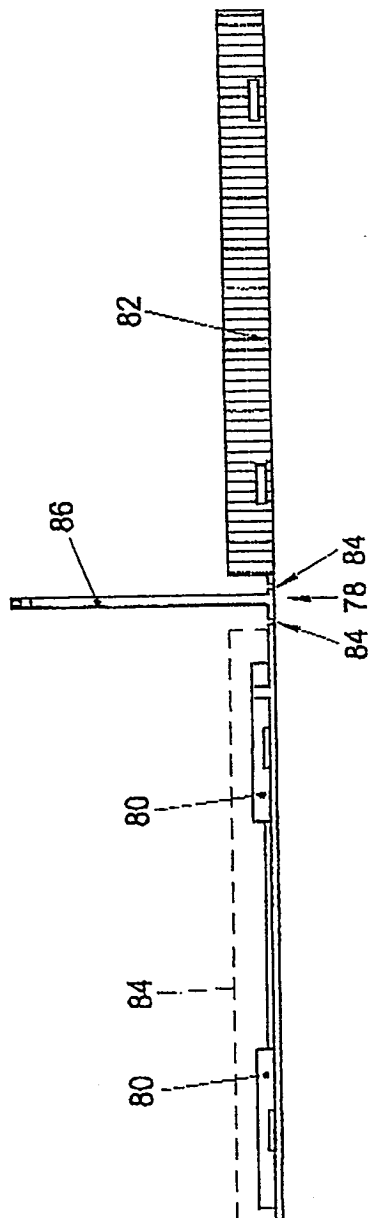


Fig. 5



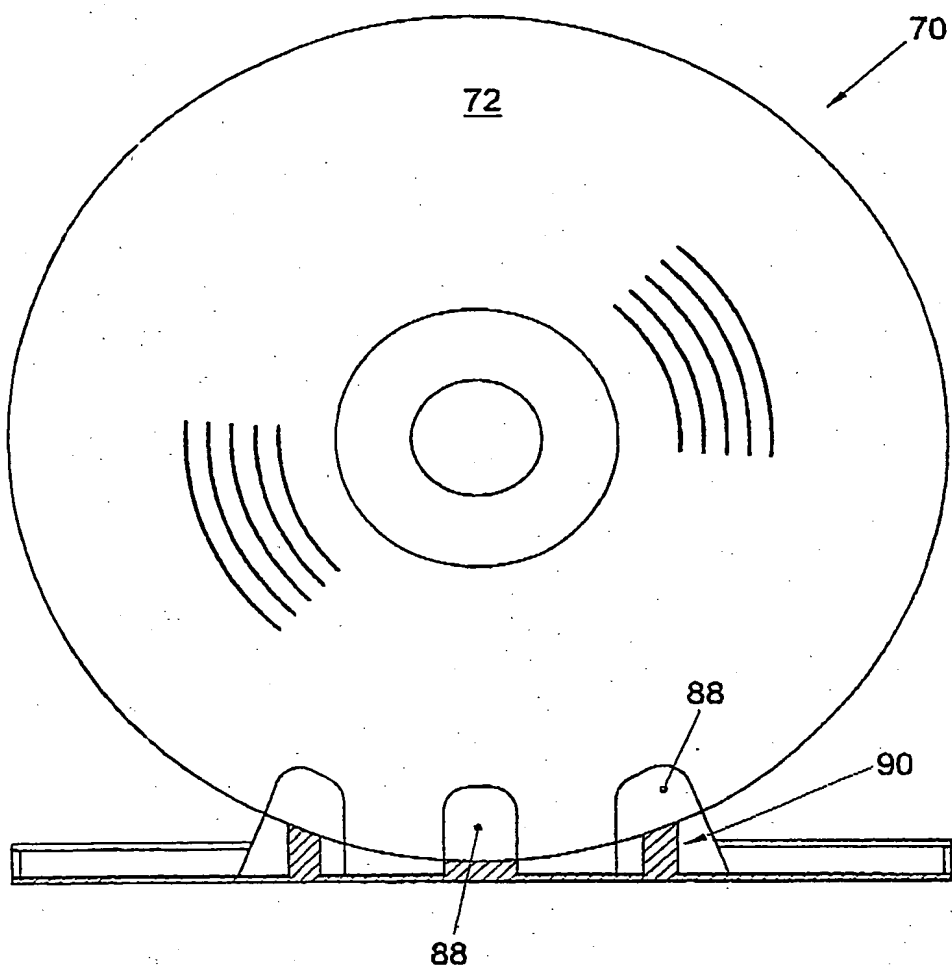


Fig. 8

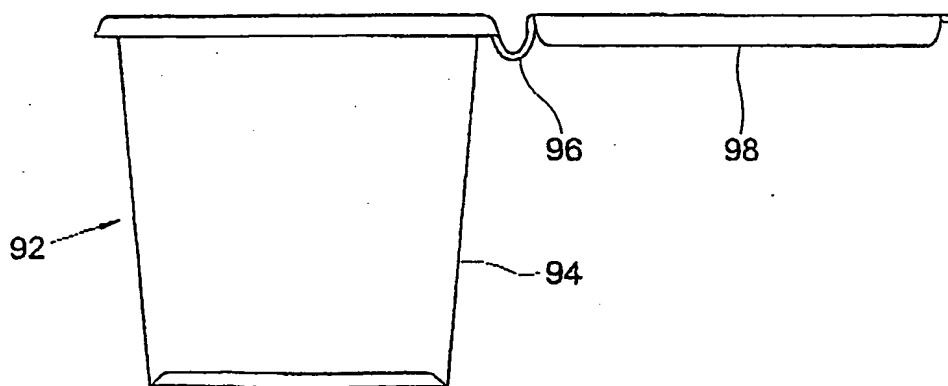
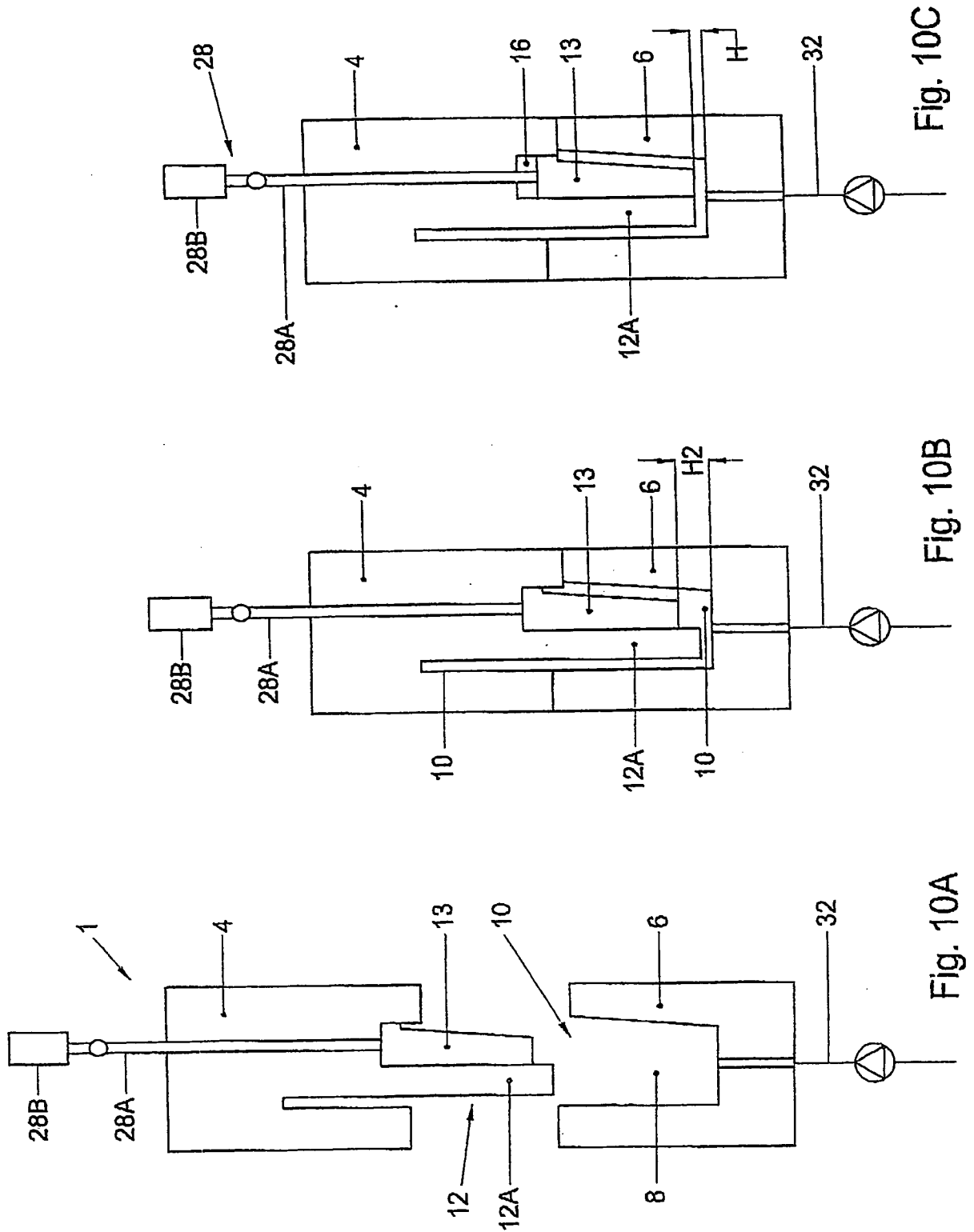


Fig. 9





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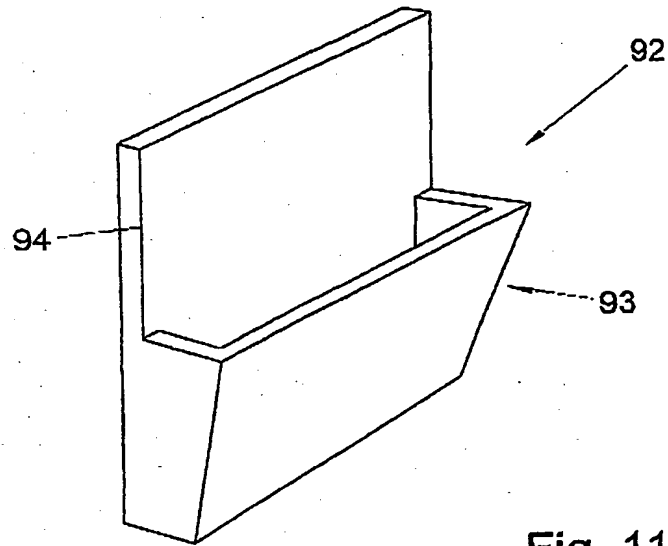


Fig. 11

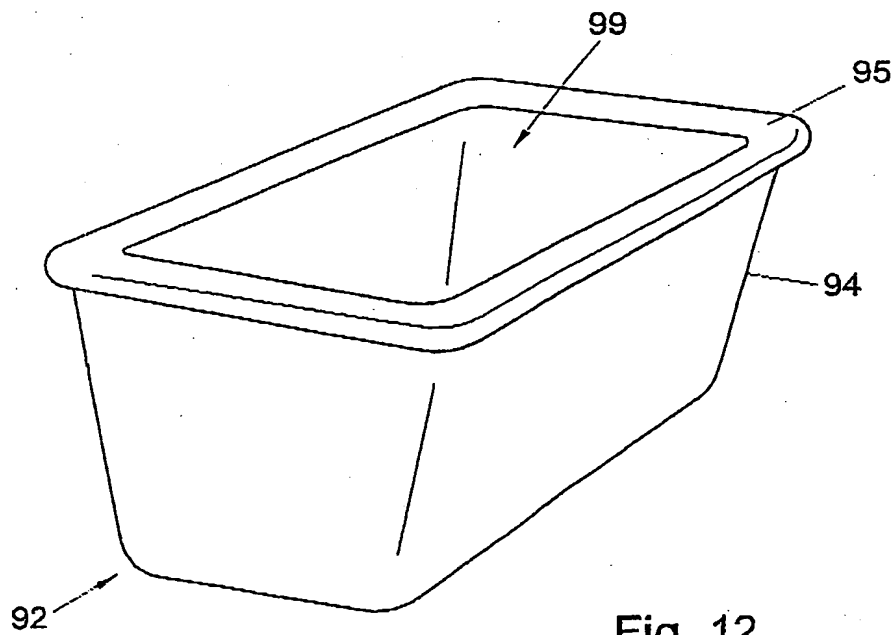


Fig. 12

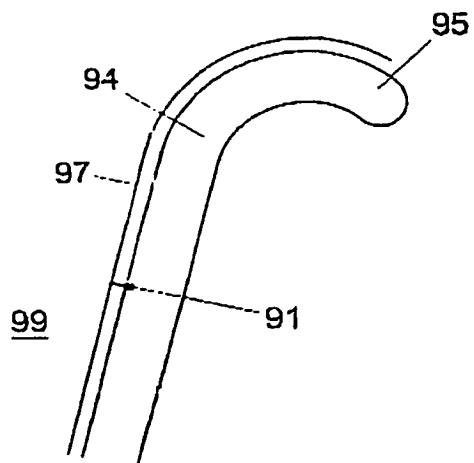


Fig. 13A

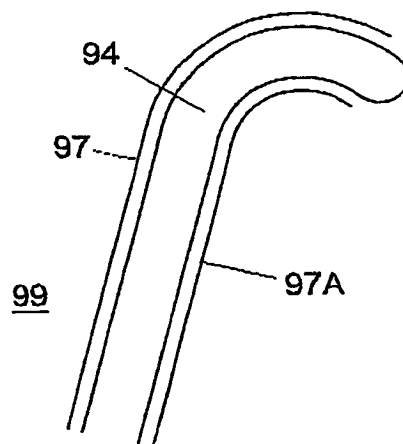


Fig. 13B

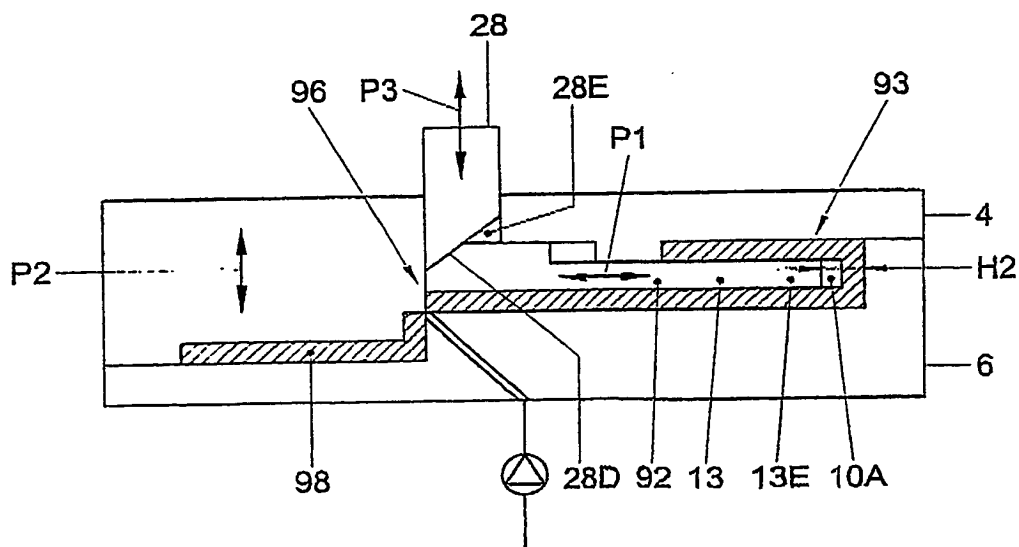


Fig. 14

## INTERNATIONAL SEARCH REPORT

PCT/NL 02/00680

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B29C45/56 B29C45/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A X X	US 4 489 033 A (UDA NAOTAKE ET AL) 18 December 1984 (1984-12-18) the whole document  US 2001/010412 A1 (KLOTZ BERND) 2 August 2001 (2001-08-02) the whole document  PATENT ABSTRACTS OF JAPAN vol. 14, no. 393 (M-1015), 24 August 1990 (1990-08-24) & JP 02 147225 A (MATSUSHITA ELECTRIC IND CO LTD), 6 June 1990 (1990-06-06) abstract  -/-	1-3,6,27  8-11, 15-17,30 18  1,3,4,6, 27  1,3,6, 27,28

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

22 January 2003

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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